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COMMITTEE ON THE DEVELOPMENT AND
UTILIZATION OF NEW AND RENEWABLE
SOURCES OF ENERGY

Fifth session

26 March-4 April 1990

Item 2 of the provisional agenda

ADOPTION OF THE AGENDA AND ORGANIZATION OF WORK

Provisional agenda

1. Election of officers.
2. Adoption of the agenda and organization of work.
3. Substantive themes selected for detailed discussion:
 - (a) Follow-up action on the conclusions and recommendations of the Castel Gandolfo Colloquium of High-level Experts on New and Renewable Sources of Energy;
 - (b) Follow-up action on information systems;
 - (c) Contribution of new and renewable sources of energy to integrated rural development;
 - (d) Direct solar-to-electrical energy conversion;
 - (e) Utilization of agricultural residues and urban wastes for energy production.
4. Implementation of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy:
 - (a) Monitoring the implementation of the Nairobi Programme of Action and the activities of the organs, organizations and bodies of the United Nations system in the field of new and renewable sources of energy;

- (b) Recommendation of policy guidelines for different organs, organizations and bodies within the United Nations system with regard to new and renewable sources of energy on the basis of the Nairobi Programme of Action;
 - (c) Formulation and recommendation of action-oriented plans and programmes for carrying out the Nairobi Programme of Action in accordance with the priorities identified therein;
 - (d) Promotion of the mobilization of financial resources required in the implementation of the Nairobi Programme of Action;
 - (e) Inter-agency co-ordination for the implementation of the Nairobi Programme of Action.
- 5. Consideration of the draft medium-term plan in the field of new and renewable sources of energy.
 - 6. Provisional agenda for the sixth session of the Committee.
 - 7. Adoption of the report of the Committee on its fifth session.

Annotations

1. Election of officers

In accordance with established practice, the Committee may wish to elect a Chairman, three Vice-Chairmen and a Rapporteur.

2. Adoption of the agenda and organization of work

By resolution 37/250, the General Assembly decided that the Committee should meet once every two years in even numbered years. The provisional agenda was approved by the Committee at its fourth session.

3. Substantive themes selected for detailed discussion:

- (a) Follow-up action on the conclusions and recommendations of the Castel Gandolfo Colloquium of High-level Experts on New and Renewable Sources of Energy;
- (b) Follow-up action on information systems;
- (c) Contribution of new and renewable sources of energy to integrated rural development;
- (d) Direct solar-to-electrical energy conversion;
- (e) Utilization of agricultural residues and urban wastes for energy production.

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In resolution 2 (IV), the Committee welcomed the Colloquium of High-level Experts on New and Renewable Sources of Energy held at Castel Gandolfo, Italy, from 5 to 7 October 1987 and took note with appreciation of its report. The Committee called for the active implementation of the following proposals contained in the conclusions and recommendations of the Colloquium: for the short term, the carrying out of activities in the areas of efficient utilization of energy, the identification of success stories, the identification of "threshold" innovations and the promotion of joint ventures in developing countries; and for the longer term, the studying of the feasibility of a comprehensive network of centres of excellence of international scope in the field of new and renewable sources of energy building on the positive experience of the existing network while avoiding undue duplication.

Also in resolution 2 (IV), the Committee requested the Secretary-General to convene, in consultation with interested States, an ad hoc panel of experts to prepare specific recommendations regarding information systems on new and renewable sources of energy on the basis of the information provided by delegations during the fourth session as well as other relevant information on the subject.

In the same resolution, the Committee requested the Secretary-General to promote the foregoing follow-up actions and to report to the Committee at its fifth session on the progress achieved.

In resolution 1 (IV), the Committee decided to include in the provisional agenda for the fifth session, for detailed consideration, the following themes: the contribution of new and renewable sources of energy to integrated rural development, direct solar-to-electrical energy conversion and the utilization of agricultural residues and urban wastes for energy production. The Committee requested the Secretary-General to prepare analytical reports for consideration by the Committee at its fifth session based on an in-depth study of the current stage of achievements in States regarding the selected themes.

The Committee will have before it the report of the Secretary-General on progress achieved in implementing the proposals contained in the conclusions and recommendations of the Castel Gandolfo Colloquium of High-level Experts on New and Renewable Sources of Energy, and on progress achieved in convening the ad hoc panel of experts regarding information systems on new and renewable sources of energy.

The Committee will also have before it a note by the Secretary-General containing the report of the United Nations Group of Experts on the Role of New and Renewable Sources of Energy in Integrated Rural Development, held at Stockholm from 22 to 26 January 1990. The report will deal with the utilization of agricultural residues for energy production as an integral part of the question of integrated rural development. Reports will also be submitted to the Committee on direct solar-to-electrical energy conversion and on the utilization of urban wastes for energy production.

Documentation

Report of the Secretary-General on progress achieved in implementing the recommendations of the Castel Gandolfo Colloquium of High-level Experts on New and Renewable Sources of Energy and information systems in the area of new and renewable sources of energy (A/AC.218/1990/2)

Note by the Secretary-General containing the report of the United Nations Group of Experts on the Role of New and Renewable Sources of Energy in Integrated Rural Development (A/AC.218/1990/4)

Report of the Secretary-General on direct solar-to-electrical energy conversion (A/AC.218/1990/6)

Report of the Secretary-General on the utilization of urban wastes for energy production (A/AC.218/1990/7)

4. Implementation of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy:

- (a) Monitoring the implementation of the Nairobi Programme of Action and the activities of the organs, organizations and bodies of the United Nations system in the field of new and renewable sources of energy;
- (b) Recommendation of policy guidelines for different organs, organizations and bodies within the United Nations system with regard to new and renewable sources of energy on the basis of the Nairobi Programme of Action;
- (c) Formulation and recommendation of action-oriented plans and programmes for carrying out the Nairobi Programme of Action in accordance with the priorities identified therein;
- (d) Promotion of the mobilization of financial resources required in the implementation of the Nairobi Programme of Action;
- (e) Inter-agency co-ordination for the implementation of the Nairobi Programme of Action.

In resolution 2 (III), the Committee invited all Governments, appropriate international financial institutions and organs, organizations and bodies of the United Nations system to continue their support and to intensify their efforts towards accelerated and comprehensive implementation of the Nairobi Programme of Action.

Also in resolution 2 (III), the Committee urged that greater attention be given to the development of new and renewable sources of energy for the rural sector and to the integration of rural energy activities with the overall needs and requirements of the rural economy, and stressed the need to devote substantial attention to energy planning and to integrate energy strategies in overall planning

for economic and social development. The Committee suggested that appropriate emphasis should be given to environmental protection and to finding non-polluting energy sources, and urged the full implementation of the Nairobi Forward-looking Strategies for the Advancement of Women, in particular the paragraphs on women and energy.

In the same resolution, the Committee emphasized the need to actively pursue ways and means of mobilizing adequate additional financial resources commensurate with the needs of developing countries in the field of new and renewable sources of energy and the importance of positive measures for promoting investment in accordance with national laws and regulations, plans and priorities. The Committee recommended that ways and means be devised so as to ensure proper preparation and effective follow-up of consultative meetings in order to enhance their effectiveness and lead, inter alia, to the mobilization of additional resources in support of specific projects and programmes. It endorsed the need to strengthen the Energy Account of the United Nations Development Programme, and invited the Programme to submit to the Committee at its forthcoming sessions a comprehensive report on its activities in the field of new and renewable sources of energy.

In resolution 41/170, the General Assembly took note of the report of the Committee on its third session, endorsed the resolutions and decision contained therein and reaffirmed the significance and importance of the Nairobi Programme of Action as the basic framework for action by the international community and the United Nations system in that field. The Assembly reiterated the need to utilize fully existing channels, including the United Nations Trust Fund for New and Renewable Sources of Energy, and actively to pursue ways and means of mobilizing adequate additional financial resources, commensurate with the needs of developing countries in the field of new and renewable sources of energy, and invited all the organizations of the United Nations system concerned to take the necessary steps to contribute effectively to the preparation, convening and follow-up of consultative meetings at the national, subregional, regional and global levels for the appraisal of projects and the mobilization of additional financial resources for the implementation of the Nairobi Programme of Action.

In the conclusions and recommendations adopted by the Committee at its fourth session (A/43/36, sect. VIII), the Committee emphasized the importance of consultative meetings as a mechanism for the mobilization of additional financial resources. The Committee recommended that appropriate preparations for consultative meetings and adequate follow-up action be carried out in order to enhance their effectiveness in mobilizing financial resources. The Committee recommended that consideration be given to innovative approaches in the preparatory process and the scope of the meetings. In that respect, in addition to national, regional and global meetings, meetings centred on specific sources of energy, specific technologies or specific applications and the interregional replication of successful regional projects could also be envisaged. The Secretary-General was requested to report to the Committee at its fifth session on the progress achieved.

In resolution 1 (IV), the Committee requested the Secretary-General to prepare for the fifth session of the Committee a report on the activities of the United Nations system concerning the contribution of new and renewable sources of energy

to integrated rural development, direct solar-to-electrical energy conversion and the utilization of agricultural residues and urban wastes for energy production, in order to facilitate a more effective exchange of information and experience regarding the development and utilization of new and renewable sources of energy.

In the same resolution, the Committee invited interested States and organizations of the United Nations system as well as other interested organizations to convene, without additional costs for the United Nations regular budget, technical and scientific meetings related to the substantive themes for the fifth session of the Committee that would contribute to their in-depth examination, and to inform the Committee at its fifth session of the results of those meetings.

In resolution 2 (III), the Committee endorsed the importance of increasing inter-agency co-ordination within the United Nations system in order to enhance the effectiveness of the implementation of the Nairobi Programme of Action and to increase the responsiveness of the United Nations system.

In the conclusions and recommendations adopted by the Committee at its fourth session (A/43/36, sect. VIII), the Committee reiterated the importance of effective co-ordination within the United Nations system for the implementation of the Nairobi Programme of Action, and the Inter-Agency Group on New and Renewable Sources of Energy was called upon to intensify its efforts for enhanced co-ordination of activities within the United Nations system. The Secretary-General was requested to report to the Committee at its fifth session on the progress achieved.

Also in the conclusions and recommendations, the Committee agreed that implementation of the Nairobi Programme of Action required sustained and continuous effort by the United Nations system through the preparation and execution of programmes and projects, in accordance with national plans and priorities. To that end, a process of successive generation of project and programme proposals would be required. The United Nations system was requested to prepare for each session of the Committee a report containing new project proposals and an update of existing ones, if required, together with information on the status of implementation of the preceding set of projects and programmes.

The Committee will have before it the report of the Secretary-General on the activities carried out by entities within the United Nations system concerning the contribution of new and renewable sources of energy to integrated rural development, direct solar-to-electrical energy conversion and the utilization of agricultural residues and urban wastes for energy production. It will also have before it reports of the Secretary-General on progress achieved with respect to resource mobilization, and on project proposals of entities within the United Nations system and the status of their implementation. A representative of the United Nations Development Programme will make an oral statement on activities in the field of new and renewable sources of energy, including up-to-date information on the status of the Energy Account of UNDP.

Documentation

Report of the Secretary-General on activities carried out by entities within the United Nations system concerning the contribution of new and renewable sources of energy to integrated rural development, direct solar-to-electrical conversion and the utilization of agricultural residues and urban wastes for energy production (A/AC.218/1990/5)

Report of the Secretary-General on progress achieved with respect to resource mobilization, including consultative meetings, and inter-agency co-ordination (A/AC.218/1990/8)

Report of the Secretary-General on project proposals of entities within the United Nations system and the status of their implementation (A/AC.218/1990/9)

Note by the Secretary-General transmitting the report on new and renewable sources of energy and the environment prepared by the Inter-Agency Group on New and Renewable Sources of Energy of the Administrative Committee on Co-ordination (A/AC.218/1990/3)

5. Consideration of the draft medium-term plan in the field of new and renewable sources of energy

Members of the Committee will recall that, in accordance with the decision of the General Assembly in resolution 43/219, a draft of the programme on energy, including new and renewable sources of energy, of the medium-term plan for the period 1992-1997 was circulated to them for their views and comments in 1989. In view of the limited number of replies received from Member States, a revised draft of the same programme, taking into account, as appropriate, the views and comments received by the Secretariat as well as recent developments in the field of energy is submitted to the Committee for further consideration of the part relating to new and renewable sources of energy.

Documentation

Draft programme on energy, including new and renewable sources of energy, of the medium-term plan for the period 1992-1997

6. Provisional agenda for the sixth session of the Committee

The attention of the Committee is drawn to General Assembly resolutions 33/56, 34/50 and 36/117 A and decision 37/445 concerning the control and limitation of documentation. In decision 37/445, the Assembly endorsed the recommendation contained in the annex to Economic and Social Council resolution 1982/50 that the documentation and programme of work of the subsidiary bodies of the Council and the Assembly should be streamlined, and that the Council and the Assembly should continue to review the provisional agenda for their subsidiary bodies, together with the list of requested documentation.

The Committee will have before it a note by the Secretariat on the provisional agenda for the sixth session and the documents to be submitted under each item.

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Documentation

Note by the Secretariat on the provisional agenda for the sixth session of the Committee

7. Adoption of the report of the Committee on its fifth session

In accordance with General Assembly resolution 37/250, the Committee submits its reports and recommendations to the General Assembly through the Economic and Social Council.

The attention of the Committee is drawn to General Assembly resolution 37/14 C, in which the Assembly reiterated that subsidiary organs should strive to keep their reports within the desirable limit of 32 pages, and requested all subsidiary organs whose reports exceeded that limit to submit to the Committee on Conferences, prior to its next session, reasons for non-compliance.



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ORIGINAL: ENGLISH

COMMITTEE ON THE DEVELOPMENT AND
UTILIZATION OF NEW AND
RENEWABLE SOURCES OF ENERGY
Fifth session
26 March-4 April 1990
Item 3 of the provisional agenda*

SUBSTANTIVE THEMES SELECTED FOR DETAILED DISCUSSION

Progress achieved in implementing the recommendations of the
Castel Gandolfo Colloquium of High-level Experts on New and
Renewable Sources of Energy and information systems in the
area of new and renewable sources of energy

Report of the Secretary-General

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* A/AC.218/1990/1.

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INTRODUCTION

1. The Committee on the Development and Utilization of New and Renewable Sources of Energy, at its fourth session, requested the Secretary-General to prepare a report on the progress achieved in implementing the recommendations of the Castel Gandolfo Colloquium of High-level Experts on New and Renewable Sources of Energy. Section I of this report has been prepared in response to that request. The Committee also requested the Secretary-General to convene, in consultation with interested States, an ad hoc panel of experts to prepare specific recommendations regarding information systems on new and renewable sources of energy. However, as explained in section II below, it has not been possible to convene such a panel.

I. PROGRESS ACHIEVED IN IMPLEMENTING THE RECOMMENDATIONS OF THE CASTEL GANDOLFO COLLOQUIUM OF HIGH-LEVEL EXPERTS ON NEW AND RENEWABLE SOURCES OF ENERGY

A. Background

2. As a follow-up to the recommendations made at the fourth session of the Committee concerning the implementation of the proposals made by the Castel Gandolfo Colloquium, the Director-General for Development and International Economic Co-operation established the Consultative Group on New and Renewable Sources of Energy. The Consultative Group, whose members were appointed in their personal capacity on the basis of their expertise, is to provide advice and guidance concerning the feasibility of establishing a network of centres of excellence of international scope for new and renewable sources of energy based on the successful experience of the Consultative Group on International Agricultural Research (CGIAR).

3. In preparation for the meeting of the Consultative Group, the Office of the Director-General for Development and International Economic Co-operation, the United Nations University (UNU) and the Italian National Agency for Nuclear and Alternative Energy (ENEA) undertook field missions to particular CGIAR centres and centres for new and renewable sources of energy in developing countries. Meetings were also held with both the Ford and Rockefeller Foundations, which contributed to the creation of the CGIAR network. Specific studies on research priorities and ecological-geographical regions were undertaken by UNU to help the Consultative Group decide upon the actual centres for new and renewable sources of energy to be included in the network. Other entities within the United Nations system have also provided relevant information.

4. The Consultative Group held its first meeting in Rome, on 27 and 28 April 1989, under the chairmanship of Umberto Colombo, Chairman of ENEA. Funding was provided by the Government of Italy. The conclusions of the Consultative Group are summarized below.

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B. Conclusions of the Consultative Group on New and Renewable Sources of Energy

5. Since the Castel Gandolfo Colloquium in October 1987, the energy situation has evolved in the right direction. Low prices have led to increased oil consumption at the world level. The increase has been particularly marked in the United States of America and Japan but less so in Europe. In developing countries, the increase in consumption has more or less followed the growth in population. At the same time, low prices have discouraged new exploration, especially in high-cost areas where production has also been decreasing. These facts, taken together, point towards the probability of greater tension in the oil market. It is likely that the growth in prices during the 1990s will be gradual, rather than marked by shocks, countershocks and extreme instabilities. Generalized economic crises have proven negative for consuming and producing countries alike. Furthermore, the kinds of political turmoil that triggered the two energy crises of the 1970s are now less likely to occur. However, oil prices will probably continue to rise slowly but continuously, independent of the physical exhaustion of reserves, unless serious (and today, unlikely) measures are taken.

6. Environment and climate, rather than energy prices, are today providing the most important and most generally perceivable motivation in the quest for new and renewable sources of energy. Recognition of the damages, some of them irreversible, caused by the use of fossil fuels to the environment, the ecosystem and the quality of life has spread in the past two years at an unprecedented pace. Concern about the damages produced by atmospheric pollution, acid rain or the greenhouse effect is no longer limited to scientific quarters or to "green" movements. There is growing concern among the public and in the political arena. The consequences of burning coal or oil without appropriate abatement of pollutants may be unbearable even from a purely economic point of view; clean technologies (except for carbon dioxide emission) are available but expensive. Comparisons of new and renewable sources of energy with traditional sources have to be made anew, and they are likely to be more favourable to the new solutions when all factors are taken into consideration. None the less, developing countries often lack investment capital and adequate infrastructure for effective programmes of energy conservation and for further development and utilization of new and renewable sources of energy. To help them overcome such difficulties, it is important to foster concrete and effective co-operation activities in this field. Working towards the implementation of the new and renewable sources of energy network proposed at Castel Gandolfo represents an important step in that direction.

7. With this in mind, the Consultative Group examined the history and functioning of the agricultural research centres of the Consultative Group on International Agricultural Research (CGIAR). It was hoped that their experience would provide guidance on the pitfalls to be avoided and the positive factors that could be used to create a lively network of centres in the field of new and renewable sources of energy.

8. In fact, 20 years after their establishment, the CGIAR centres continue to be a source of inspiration in various areas of activity. The main factors that have contributed to the success of the CGIAR centres are their high-priority objectives,

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their clearly defined mandate and mission-oriented strategy, and their ability to work on promising technologies, to set up a viable system of research and development and to recruit, on an international basis, highly qualified scientific and managerial staff. In all of this, they have been greatly assisted by the overall CGIAR system, which has helped to establish policies, set priorities, mobilize funds and ensure accountability.

9. The Consultative Group focused its discussion on the types of mission and the geographical locations for new and renewable sources of energy most suitable for the centres. As regards the mission, two approaches were considered: by technology and by end-use. The first approach, of a top-down nature, would favour the creation of centres of excellence, or the upgrading of existing centres, in several developing countries, each one committed to research and development in a single technological area. This approach would put the emphasis on the research mission of the centres. It would make it possible to define more clearly the tasks performed by the various centres and promote world-wide networking with other institutions working on the same technology.

10. The second approach, of a bottom-up nature, would assign to each centre a mission based on the satisfaction of one or more specific energy requirements, thus addressing directly the needs of the end-users and facilitating their involvement in all stages of research and development and in the dissemination and application of research results. Such an approach would place strong emphasis on energy conservation and on a more rational use of energy. Furthermore, since many international agencies operate in specific sectors, such as health, agriculture or industry, this approach would improve the possibility of fruitful interaction with these agencies. These two approaches would not necessarily be mutually exclusive and could be appropriately combined. The table indicates how they could be integrated.

11. Non-technological activities should also be carried out within the network. Following the CGIAR experience, each centre could devote a certain percentage of its resources to planning, training, dissemination and extension work. Operating on a world-wide scale and forming a link between basic and strategic research and applied research carried out by national research institutions throughout the developing world, the centres could play an important role in disseminating information on new technology to national institutions, where further work could be done to adapt the technology to local circumstances. In addition, one or two centres could specialize in the provision of services to other network centres, and to developing countries as a whole, in such areas as training, technology assessment, socio-economic impact analysis and project evaluation. They could also provide advice on planning, organization and management of national research and development programmes.

Preliminary view of currently available applications of new and renewable
sources of energy to specific end-uses in developing countries

	Clean water supply	Health sector	Food preser- vation	Domestic- thermal	Domestic- electric	Electricity (village)	Electricity (grid)	Trans- portation
Photovoltaic	X	X	X		X	X		
Solar thermal	X	X	X	X				
Minihydro						X	X	
Geothermal						X	X	
Wind	X				X	X	X	?
Large biomass						X	X	X
Small biomass				X		X		
Biogas				X				
Ocean						X		
End-use equipment	X	X	X	X	X	X		X

12. As for the geographical location of the centres, countries could be selected on the basis of their high level of expertise in a given technology or the existence of a specific opportunity with regard to a given energy source. Mexico or the Philippines might be considered for geothermal energy; India or China for biogas; Argentina, China or another Pacific country for wind energy; Brazil for large-scale biomass; India or Brazil for photovoltaics; one of the Sahel countries or Kenya for small biomass; one of the North African countries for solar/thermal energy and desalination; China or one of the Latin American countries for mini-hydro energy.

13. Bearing in mind the UNU report on ecological-geographical regions, which emphasizes the strong influence of climatic conditions and the availability of natural resources on the development of new and renewable sources of energy, other centres could be set up and/or upgraded in at least some regions. Areas with critical problems, such as water supply and woodfuel shortages, should also have specialized centres associated with the network.

14. Further efforts to develop an open list of possible missions for the centres for new and renewable sources of energy and of geographical locations should attempt to integrate the various approaches examined so far. However, excessive systematization should be avoided, since the list must serve as a useful and flexible tool from which donors and developing countries may choose the specific areas of activity and the location of the international centre they wish to support. Several prerequisites must be met in the selection of centres to be upgraded or in the creation of new centres of excellence. The centres must be capable of:

- (a) Interacting with local authorities in a constructive manner;
- (b) Producing good research (which requires adequate human and financial resources);
- (c) Applying and usefully disseminating the results of their research by establishing close links with industries and users and also through well-targeted training activities;
- (d) Introducing some degree of internationalization;
- (e) Sustaining themselves by raising funds and procuring outside contracts and consultants, after an initial period during which they would receive bilateral and/or multilateral financial assistance.

15. The networking scheme, as exemplified by CGIAR, can essentially be applied to the use of new and renewable sources of energy. Other examples of networking do exist, such as the Co-operative Network on Rural Energy of the Food and Agriculture Organization of the United Nations (which deals with various energy sources), the Biomass Users Network and the Charcoal Network. These networks are limited to specific technologies or fields of application. They connect existing centres, which operate mostly at the national level and devote only part of their activities to international co-operation. This type of network is also present, in some cases, within the CGIAR framework, where one centre connects with universities and other research institutions active in the same field in different countries.

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16. In the long term, the network of centres of excellence for new and renewable sources of energy could be structured along two levels. The first level would include a limited number of centres with an international dimension and would include existing centres as well as new ones. As in the case of the CGIAR network, the activities of these centres would be overseen by a group composed of donor countries, multilateral agencies and developing countries involved in the initiative.

17. Drawing upon the networking experiences mentioned above, a second level of networking would be built around each centre. A centre would act as a focal point in a sub-network of existing research centres operating in the same field in both the host country and other countries.

18. In the short term, the Consultative Group agreed on a gradual approach to the creation of the network for new and renewable sources of energy, starting with a few concrete and concerted actions. Three or four centres of excellence of international scope should be established, possibly by upgrading existing institutions, and should act as focal points for the creation of networks around them. These centres should exchange information and experiences, thus obtaining synergic effects in research work and the utilization of research results. To reach the expected level of excellence, they should be helped by interested donors, who would provide the necessary resources, including research and development equipment and skilled personnel. As the centres gained experience in co-operating with one another, they could undertake flexible and non-bureaucratic activities in co-ordination.

19. For the creation of the first group of centres, donors should concentrate separately or jointly on one or more centres. They should work in a concerted manner with the help of the United Nations, which should continue to play a catalytic role. To that end, it was agreed that the members of the Consultative Group would verify with their respective Governments their willingness to undertake start-up actions, following the preliminary interest already expressed by some countries. A few members representing donors and developing countries would meet shortly with the Director-General for Development and International Economic Co-operation and other United Nations officials to determine what further action should be taken. In the mean time, the pre-feasibility survey should continue, and efforts should be concentrated on preparing the open list mentioned above in paragraph 14, as well as on revising the questionnaire previously sent to selected information systems (see annex II). The questionnaire should then be sent, as soon as possible, to existing centres for new and renewable sources of energy and to other institutions in developing countries that could provide useful information for the survey.

20. The results of these activities will be discussed at the next meeting of the Consultative Group, with the participation of the most concerned United Nations bodies, and the final report of the Group will be prepared. The report will be submitted to the Committee on the Development and Utilization of New and Renewable Sources of Energy at its next session.

II. SYSTEMS OF INFORMATION

A. Background

21. At its third session (1986), the Committee decided to adopt a substance-oriented approach that would enable it, at each of its sessions, to give depth to its deliberations by placing on the agenda one or two specific themes. Systems of information in the field of new and renewable sources of energy was one of the themes chosen for consideration at the Committee's fourth session (1988). The Committee requested the Secretary-General to prepare a report on the activities of the United Nations system, inter alia, in the field of information systems in order to facilitate a more effective exchange of information and experience regarding the development and utilization of new and renewable sources of energy.

22. The report submitted to the Committee at its fourth session in response to that request (A/AC.218/13) concluded that in order to assess whether the requirements and needs for information on new and renewable sources of energy were being fully met by the available information systems, it would be necessary to consider not only the information systems within but also those outside the United Nations system.

23. The Committee, after considering the report, reiterated that information flows on the development and use of new and renewable sources of energy was one of the areas given priority in the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy and requested the Secretary-General to convene an ad hoc panel of experts on the subject.

B. Action taken in relation to convening an ad hoc panel of experts

24. A number of Governments were approached regarding the possibilities of funding and hosting an ad hoc panel of experts on information systems on new and renewable sources of energy, as requested by the Committee. While Governments expressed interest in the subject and reiterated its importance, no positive offer to finance a panel has been forthcoming.

25. States Members of the United Nations were, meanwhile, requested to provide information on their information systems on new and renewable sources of energy and related activities. Consultants were contacted for the preparation of a comprehensive report that would assess and evaluate available information systems, both within and outside the United Nations system, in relation to requirements, particularly in developing countries. That report was also to be used as a background document for consideration by the proposed panel of experts. However, the consultants contacted indicated that they would need to undertake extensive discussions with both the providers and users of information, which would require travel to different parts of the world. Alternatively, they would have to prepare a detailed questionnaire to elicit responses from the providers and users. They would also need to undertake a thorough evaluation of the information available from the existing systems. Such an evaluation would entail accessing on-line databases, and conducting extensive searches to assess the value and usefulness of

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various information systems, particularly for developing country users in different categories. The undertaking would be very costly and no financing was available.

26. A questionnaire was sent by the United Nations Secretariat to a selected number of information systems active in the field of new and renewable sources of energy. The formulation of the questionnaire benefited from the United Nations Educational, Scientific and Cultural Organization International Directory of New and Renewable Energy Information Sources and Research Centres and from statements made by members of the Committee on the Development and Utilization of New and Renewable Sources of Energy at its fourth session. The questionnaire is reproduced in annex II. The information systems to which the questionnaire was sent are listed in annex III. The list is by no means exhaustive. Forty-four questionnaires were sent out; 17 information systems, or 39 per cent of the total, have responded so far.

27. From the responses to the questionnaire and other reports available, the following observations can be made:

(a) Most systems participate in one network or another, especially in developing countries; this gives them access to a larger central organization that could subscribe to one of the international database distributors; this could, in turn, give them access to even larger technical and scientific bibliographical databases located mainly in developed countries, as well as to larger libraries that distribute hard copy;

(b) Of the 17 respondents, 11 indicated that they had a consultancy or research organization attached to the information system. This is welcome because of the value of having access to an expert with whom to communicate verbally and discuss relevant issues and problems;

(c) The quickest and most efficient way to get information to developers and users of new and renewable sources of energy may be to help the interested parties build up personal networks by organizing or participating in meetings, conferences and seminars and exchanging ideas with others active in specific fields;

(d) Of the respondents that indicated the percentage of their system that covered new and renewable sources of energy, three were in the 0-25 per cent range, six in the 25-50 per cent range, one in the 51-75 per cent range and three in the 76-100 per cent range. A number of the systems also indicated how many records or entries the given percentage would signify; the answers varied from a total of 100 to 90,000 new entries per year. It is not clear, however, whether the term "records or entries" means bibliographical references, books, detailed reports on a technology, extensive studies or a mixture thereof;

(e) The types of users most often mentioned were government officials, other network participants, village libraries, research and development personnel, bilateral and multilateral staff, and non-governmental and private organizations. In some cases, a user is also a provider of information;

(f) Many of the respondents were the "central" organization of a network; they indicated that they worked mostly in English, French or Spanish. However, a number of the smaller organizations active in the networks worked in local languages;

(g) Seven of the respondents indicated that some sort of evaluation of the system, its users and their needs had been or was being undertaken.

C. Conclusions and recommendations

28. It has not been possible to organize an ad hoc panel of experts on information systems in the field of new and renewable sources of energy owing to a lack of resources. The responses to the questionnaire do not, in and of themselves, make it possible to determine whether the needs and requirements of present and potential users are adequately being met.

29. There appears to be a need for a panel of experts on information systems in the field of new and renewable sources of energy. The panel would determine, inter alia, the real requirements of the different types of users and how those requirements could best be met. It would consider such issues as substantive coverage, gaps and overlaps; accessibility; awareness on the part of users; the need to standardize the type of information provided; and international and regional co-operation. There are many types of users, and they are widely scattered throughout the world; there are also numerous information systems and they provide information in many diverse forms. It is strongly believed that all of these factors can best be evaluated by a panel of experts who are drawn from different geographical regions and have experience in the management or actual use of information on new and renewable sources of energy. The Committee may wish to consider whether such a panel should be financed from the regular budget.

Annex I

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English

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Thomas BABATUNDE

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SENEGAL

/...

Annex II

QUESTIONNAIRE

The United Nations Conference on the Development and Utilization of New and Renewable Sources of Energy held in Nairobi in 1981, covered such new and renewable sources of energy (NRSE) as wind, solar, biomass conversion, fuelwood, oil-shale, tar sands, geothermal, ocean (including tidal, thermal gradient), draught animal, hydropower and peat, as well as energy conservation and energy planning.

Name of your information system:

Address:

1. What kind of information system do you provide?

☐ Libraries

☐ Experts (Consultancy)

☐ Database

Hard copy

Computerized

On-line (please note access service)

☐ Publishing

☐ Others (please elaborate) _____

2. What percentage of your system covers NRSE and how many entries would it signify?
3. Do you supply any published material covering your information system?
4. Do you use other information systems, e.g. commercial on-line databases, information centres? If so, which ones and how do you access them?
5. What is the geographical coverage of your system, e.g. national, subregional, regional or global?
6. What language do you use, e.g. English, French?
7. What kind of services do you provide, e.g. computer searches, provision of documents, referral, consulting?

/...

8. If possible, would you provide us with a list of users of your system, active in the development and utilization of new and renewable sources of energy in developing countries.?
9. Have you ever made an evaluation of the users of your information system and their needs in regard to information on the development and utilization of new and renewable sources of energy in developing countries?
10. Would you be prepared to act as a consultant for the United Nations in preparing a background document reflecting the following objectives?
 - (a) Identification of the current information requirements for the development and use of NRSE in developing countries and an assessment of whether these requirements are met by existing information systems;
 - (b) Evaluation of the accessibility of information systems and of their different forms; recommendations on how to best reach existing and potential users;
 - (c) Appraisal of the status of existing information systems on NRSE, with emphasis on (i) the availability of technological information on experience with practical applications under different conditions in developing countries and (ii) the dissemination of research, development and demonstration results.
11. Is there a research institution or consultancy service attached to your organization? If so, which one?
12. Could you suggest other experts active in the field of providing information on the development and utilization of new and renewable sources of energy in developing countries?

Contact person

Name:

Organization:

Address:

Telephone No. (include area code):

Telex No:

Facsimile:

Annex III

INFORMATION SYSTEMS TO WHICH THE QUESTIONNAIRE WAS SENT

Institution and name of information system

Africa

Botswana Technology Centre
Botswana Technical Information Services
Botswana

African Intellectual Property Organization
Information Services
Cameroon

New and Renewable Energy Authority
Egyptian Renewable Energy Development Organization
Egypt

Academy of Scientific Research and Technology
Egyptian National Science and Technology Information Network
Egypt

National Energy Board
Energy Information Centre
Ghana

REECA in Developing Countries
Environmental Liaison Centre
Kenya

Centre régional d'énergie solaire
SIERS
Mali

Centre de développement des énergies renouvelables
Morocco

Solar Energy Society of Nigeria
Information Services
Nigeria

African Centre for Technology
Division of Information and Documentation
Senegal

Centre d'études et de recherches sur les énergies renouvelables
Senegal

Environment and Development Action
Third World, ENDA-TW
Senegal

Centre national de documentation et technique
Senegal

SENSOL
Senegal

Ecole national supérieur universitaire de technologique
Senegal

University of Sierra Leone/Fourah Bay College
Department of Mechanical Engineering
Sierra Leone

Solar Energy Society of Zimbabwe
Information Services
Zimbabwe

Asia

Institute of Science and Technology Information in China
NRSE Office, ISTIC Chongqing Branch, INNRERC
China

TAT Energy Research Institute
ASSET Office, Documentation and Information
India

Royal Nepal Academy of Science and Technology
Library and Documentation Centre
Nepal

PNOC-Energy Research and Development Centre
INNERTAP
Philippines

Regional Energy Resources Information Centre/AIT
Library and Regional Document Centre
Thailand

National Energy Information Centre
Energy Policy and Planning Division
Thailand

Caribbean

Caribbean Development Bank
Technology and Energy Unit, CTCS
Barbados

Scientific Research Council
CEIS
Jamaica

Scientific Research Council
Documentation Centre
Jamaica

CARIRI
Office of External Co-ordination
Trinidad and Tobago

Central America

CEMAT
Information Services
Guatemala

Información e Innovación Tecnológica
Mexico

Europe

Osterreichisches Forschungszentrum
Austria

United Nations Industrial Development Organization
Industrial and Technological Information
Austria

Commission of the European Communities
Energy Department, SESAME
Belgium

Riso National Laboratory
Library, Nordic Energy Index
Denmark

Ministry of Trade and Industry
Energy Department
Finland

AFME
France

Groupe de recherche et d'échange technologique
France

Commission à l'énergie atomique, Centre nucléaire de Sacly
Service de documentation, ENERGI
France

United Nations Educational, Scientific and Cultural Organization
Division of Technological Research and Higher Education
France

Association bois de feu
France

Centre national de recherche scientifique
France

Fraunhofer Institut für Systemtechnik und Innovationsforschung
Federal Republic of Germany

Deutsche Forschungs und Versuchsanstalt für Luft und Raumfahrt e.V.
Federal Republic of Germany

Deutsches Zentrum für Entwicklungstechnologie
GATE
Federal Republic of Germany

Fachinformationszentrum Energie, Phy. Math.
Federal Republic of Germany

ICONDA-Agency
Federal Republic of Germany

Socially Appropriate Technology International
Information Services
The Netherlands

Beijer Institute
Sweden

International Labour Office
Environment, Energy, Human Settlements
Switzerland

USSR State Committee for Science and Technology
Energy Division
USSR

World Energy Conference
United Kingdom

Middle East

Solar Energy Research Centre
Regional Centre for NRSE Information Network
Iraq

Foundation of Scientific Research
Scientific Documentation Centre
Iraq

Union of Arab National Research Councils
Iraq

Arab Industrial Development Organization
League of Arab States
Iraq

The Royal Scientific Study
Jordan

Ministry of Energy and Mineral Resources
Jordan

Kuwait Institute for Scientific Research
Natural Sciences and Technology Information Centre
Kuwait

Organization of Arab Petroleum Exporting Countries
Kuwait

Gulf Organization for Industrial Consultants
Qatar

King Abdul Aziz City for Science and Technology
Information System
Saudi Arabia

Islamic Foundation for Science and Technology for Development
Saudi Arabia

Supreme Committee of Sciences
Commission for Science Publication
Syrian Arab Republic

North America

International Development Research Centre
Information Sciences Division, ERG
Canada

Canada Institute for Science and Technology Information
NRCC
Canada

Ministère de l'énergie et des ressources
Secteur d'énergie
Canada

National Technical Information Service
United States of America

Volunteers of Technical Assistance
United States of America

United States Department of Energy
Office of Science and Technology Information, ENERGY
United States of America

R. R. Bowker, ENERGYLINE
A & I Publishing Company
United States of America

Texas A & M University
Library, EBIB
United States of America

Business Publishers, Inc.
Solar Energy News, World Environment Report
United States of America

Environmental Studies Institute
United States of America

Pacific

Commonwealth Science and Industrial Research Organization (CSIRO)
Energy Information Service, CRRERIS
Australia

International Solar Society
Australia

South America

Centre for Science and Technology Information
Argentina

Instituto Nacional de Tecnología Industrial
División de Energía No Convencional
Argentina

PROMON
Technology Centre
Argentina

Comissão Nacional de Energia Nuclear
Divisão de Análise da Informação
Brazil

Empresa Brasileira de Assistência Técnica e Ex. Rural
Ministério da Agricultura, SEPN
Brazil

Organización Latinoamericana de Energía
Document Centre
Ecuador



General Assembly

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COMMITTEE ON THE DEVELOPMENT AND
UTILIZATION OF NEW AND RENEWABLE
SOURCES OF ENERGY
Fifth session
26 March-4 April 1990
Item 4 (e) of the provisional agenda*

IMPLEMENTATION OF THE NAIROBI PROGRAMME OF ACTION FOR THE
DEVELOPMENT AND UTILIZATION OF NEW AND RENEWABLE SOURCES OF
ENERGY: INTER-AGENCY CO-ORDINATION FOR THE IMPLEMENTATION
OF THE NAIROBI PROGRAMME OF ACTION

New and renewable sources of energy and the environment

Note by the Secretary-General

1. During the fourth session of the Committee on the Development and Utilization of New and Renewable Sources of Energy, held at the United Nations Headquarters from 28 March to 8 April 1988, many delegations stressed the importance of environmentally sound development and use of new and renewable sources of energy.
2. Since then and in the light of the increased concern about the environmental implications of energy use, the Inter-Agency Group on New and Renewable Sources of Energy during its eighth session, held in Geneva on 9 and 10 March 1989, agreed to submit to the Committee a paper on new and renewable sources of energy and environment, which is annexed to the present document.

* A/AC.218/1990/1.

Annex

1. A consensus is emerging in the world scientific community that the impact on environment by current patterns of energy production and use is one of the most urgent issues facing energy decision makers today. The aim of the present paper is thus to submit to the Committee on the Development and Utilization of New and Renewable Sources of Energy a discussion of the role of new and renewable sources of energy into the context of this new energy agenda, and the considerations contained in this paper should be understood as complementary to those contained in the Nairobi Programme of Action and compatible with them.

2. In the developed and, increasingly, the developing countries, the production of sulphur and nitrogen oxides from the combustion of fossil fuels is contributing to the acidification of forests, lakes and soils, destroying the delicate biochemical balance in many ecosystems. In many developing countries, the use of biomass fuels, particularly fuelwood, is contributing to rural deforestation. Neither acidification nor deforestation are automatic consequences of the use of fossil and biomass fuels, but the investment required to control them, in emissions-control and in sustainable land resource management, may be considerable.

3. The most uncertain but potentially the most serious energy-environment problem of all is the threat of global climate change due to the accumulation of carbon dioxide, methane and other "greenhouse" gases in the atmosphere. Current estimates indicate that roughly 50 per cent of projected global warming caused by human activity over the coming 50 years may be attributed to the energy sector, primarily to the combustion of fossil fuels.

4. Debate continues on the potential of nuclear power to provide a viable and acceptable alternative. Although new, potentially safer, reactor designs are being developed, the uncertainties involved in the disposal of nuclear waste have probably rendered any major build-up of nuclear energy politically unfeasible in most countries for several decades.

5. Most of these energy-environment problems have occurred primarily within the energy-intensive industrialized economies, although the importance of newly industrialized countries is growing rapidly. The consequences, however, increasingly are being felt by all in the form of transboundary pollution and anticipated global climatic changes. The adverse impact on the environment resulting from current patterns of energy production and use points to the need for a transition to a better energy mix that is less damaging to the environment and more compatible with the emerging concepts of sustainable development.

6. With energy supply shortfalls in the near future no longer heading the agenda, what is needed is a new approach to energy planning and policy formulation - an approach which takes into account the external environmental and social costs of energy and which considers the full energy system from fuel source to end-user.

7. The implications for new and renewable sources of energy are twofold. First, current experience suggests that new and renewable sources of energy are inherently more environmentally benign than conventional energy sources - more specifically,

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they internalize a higher proportion of their costs. Thus the inclusion of external costs into energy decision-making will, prima facie, substantially improve the case for a greater emphasis to be placed on new and renewable sources of energy.

8. Secondly, new and renewable sources of energy should no longer be advocated simply as alternative energy sources to be plugged into the supply side of the existing world energy economy, but as integral components of future, more sustainable energy systems. The focus of energy policy decisions will increasingly need to be on efficient and environmentally-sound energy production and use to meet the growing needs of end-users, particularly the poor in developing countries.

9. The first two sections outline current energy trends and the associated key environmental impacts; the third section focuses on those environmental impacts of new and renewable sources of energy. Section four re-emphasizes that new and renewable sources of energy are no longer being advocated as an end in themselves, but as a means to a wider end: to alleviate the damage done to the environment. Section five offers recommendations on new and renewable sources of energy which should evolve out of the incorporation of environmental considerations into the energy planning process. They are compatible with the conclusions and recommendations of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy. 1/

I. WORLD ENERGY PRODUCTION AND USE

10. The present energy situation and perceptions regarding energy in the future have changed substantially since the 1981 Nairobi Conference on New and Renewable Sources of Energy. This section aims to place the subsequent discussion of environmental issues and the role of new and renewable sources of energy into the context of the current energy situation.

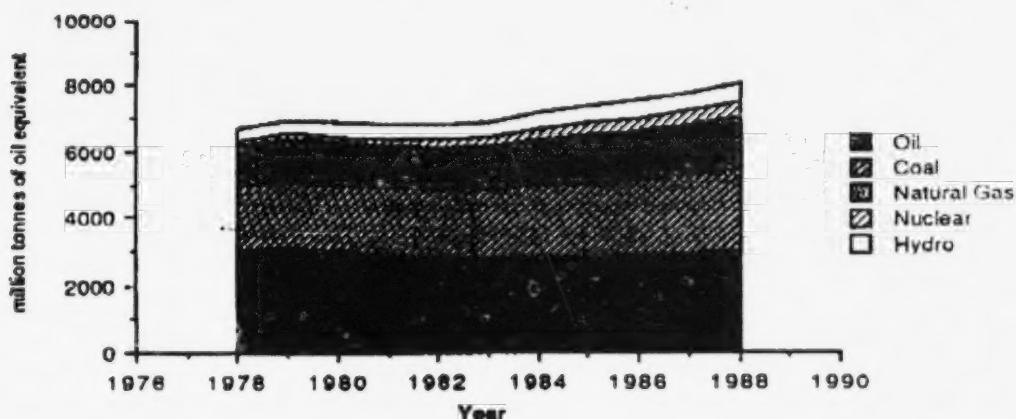
A. Recent consumption trends

11. Global consumption trends over the past 10 years for the five main commercial energy sources (oil, coal, natural gas, nuclear power and hydropower) are shown in figure 1.

12. Biomass has not been included in these figures primarily because of the lack of reliable data and the difficulty of quantifying, or even defining, biomass consumption in terms of tons of oil equivalent. Its importance, however, should not be neglected: it is the main energy source for heating and cooking for almost half the world's population, and has been estimated to provide up to 90 per cent of the energy requirements of some developing countries.

Figure 1. Global consumption trends, 1978 to 1988

World primary energy consumption
(major commercial sources only)



Source: British Petroleum, Statistical Review of World Energy, 1989.

13. The above global aggregate figures conceal important regional variations. During the period 1973 to 1985, the developed market economies reduced total energy consumption while maintaining relatively high levels of economic growth primarily through increased efficiency, price-based conservation and a shift of energy intensive industries to newly industrialized countries. Trends over the past few years indicate that the recent drop in oil prices has removed much of the pressure to conserve, and energy consumption growth has resumed.

14. There has been a gradual shift from oil to coal in all but the developing countries after the 1979-1980 oil price rise. Coal is a particularly important fuel in the centrally planned economies and in the People's Republic of China, where it contributes more than 80 per cent of commercial primary energy. Trends in nuclear power generation may be somewhat misleading, since the reactors coming on-line during the period covered by figure 1 were ordered mainly in the 1970s. Hydropower still contributes only a relatively small proportion of global energy requirements, despite its considerable potential. The total contribution of the other new and renewable sources of energy to the world commercial energy mix is of the order of 13 per cent.

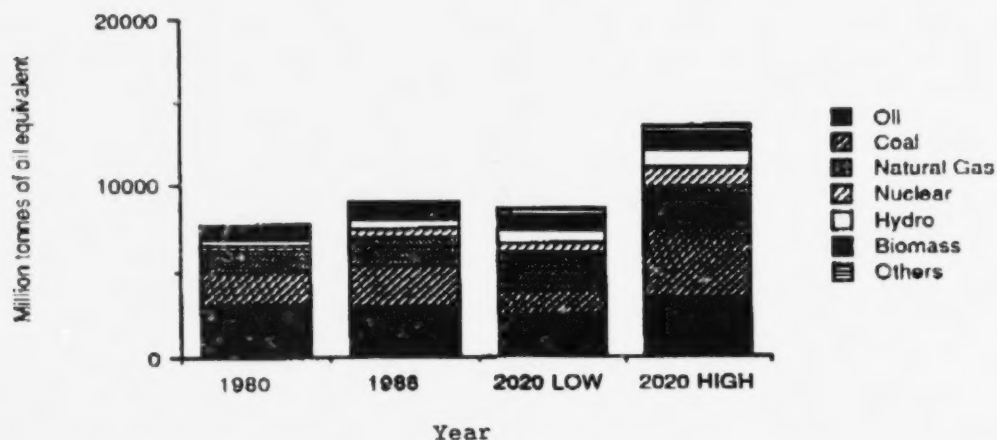
B. Energy consumption and reserves: projections to 2020

15. A large number of energy scenarios are available in the literature. Figure 2 shows two widely quoted examples to indicate the wide spread of futures which authors have considered to be technically feasible. It is important to note their different methodologies. The "low" scenario is based on the results of the End Use

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Global Energy Project (EUGEP), reflecting what is considered to be technically and economically feasible assuming consistent use of the most energy efficient systems available. The "high" is the moderate growth scenario based on the extrapolation of historical trends and economic indicators. Both scenarios assumed similar figures for average per capita economic growth (3 per cent).

Figure 2. World energy consumption projections to 2020



Sources: Goldenberg et. al., Energy for a Sustainable World (Washington, D.C., World Resources Institute, 1989) and "Energy perspectives, 2000-2020", in Proceedings of the Fourteenth World Energy Congress (Montreal, World Energy Congress, 1989).

16. Present estimates of the global production versus reserves situation for fossil fuels suggest that even in the "high" scenario, supply shortfalls are unlikely in the near future. 2/ World coal reserves are even more secure and are estimated to be around 235 times 1988 production levels. Most scenarios, therefore, envisage a heavy reliance on coal as a long-term substitute for other fossil fuels, which gives cause for serious environmental concern. Estimates of reserves of natural gas are the least certain, but have been revised upwards significantly in recent years.

17. The picture which emerges is that impending shortfalls in non-renewable energy supplies have moved off the top of the energy agenda. The environmental consequences of continuing on the world's present energy trajectory are likely to lead to limits being imposed on energy development.

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C. The contribution of new and renewable sources of energy

18. The only genuine "renewable" among the major commercial energy sources is hydropower, supplying 6.5 per cent of commercial energy consumption. Many countries still have substantial, untapped hydropower resources, particularly in the centrally planned economies and developing countries: total hydropower generation in 1987 in the Union of Soviet Socialist Republics, for example, represented only 5.7 per cent of estimated exploitable capability; in Asia, 9 per cent; in Latin America, 8 per cent; and in Africa, 5 per cent; while the equivalent figure for the United States of America was 66 per cent. 3/

19. Global exploitable hydropower potential is difficult to quantify. One recent estimate indicates that approximately 12 million GWh/year could be generated from hydro schemes larger than 1MW within the limits of current technology and under present and expected local economic conditions (WEC - 1989a). This is equivalent, with the World Energy Congress conversion factors used above, to 2,700 million tons of oil equivalent, which is almost one third of the world's current total primary energy demand and more than five times the energy produced from hydropower at present.

20. The above figures have focused on commercial sources of energy, owing to the scarcity of data on other sources. This tends to conceal the role of new and renewable sources of energy to some extent, particularly that of biomass. In the United States, for example, renewables contributed almost 8 per cent of national primary energy in 1988, more than nuclear power. Of this, almost 4 per cent was biomass energy, largely non-commercialized, generated by the direct burning of wood and wastes. 4/

21. In global terms, the contribution of the other new and renewable sources of energy, including wind, solar, geothermal and various ocean-based energies, while relatively small, is growing. However, the low world figures conceal important local applications. Geothermal energy already provides a substantial proportion (10-20 per cent) of the power requirements of El Salvador, Nicaragua, Kenya and the Philippines. 5/ Another relatively successful large-scale initiative is the alcohol fuel programme in Brazil, which produced over 15 million tons of oil equivalent in 1988 in the form of solid and liquid fuels, which may be compared with total 1988 Brazilian oil consumption of 63 million tons.

II. THE DEVELOPING ENVIRONMENTAL CRISIS

22. The main environmental impacts of the world's current and future energy trajectory are outlined below. This chapter also aims to place the subsequent discussion of the specific impacts of the different new and renewable sources of energy into a broader context.

23. The discussion below focuses on three long-range, cumulative impacts of energy production and use which are currently objects of international concern: the acidification of the atmosphere, land degradation and the changes in the world's climate. A consensus has yet to emerge on whether the fourth issue considered, the

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accumulation of radioactive material generated by nuclear power plants, constitutes a negative environmental impact at all.

A. Acidification

24. The key primary causes of acidification are sulphur dioxide (SO₂) and two oxides of nitrogen (NO and NO₂, jointly denoted by NO_x), all produced in certain combustion processes involving fossil fuels. The main anthropogenic sources of SO₂ emissions are coal-fired power stations and energy-intensive industries.

25. SO₂ emissions in developing countries are increasing rapidly due to the process of development, low utilization efficiency and lack of emission control. The sources of NO_x are less well documented than those of SO₂. The main natural sources are thought to be lightning and organic decay.

26. SO₂ and NO_x combine with water vapour in the air, causing acid precipitation. Although regionally dispersed, the effects of acid rain are highly site-specific, depending in particular on whether there are any natural bases (such as limestone) in the soil or rocks to neutralize it, and on the concentration of potentially toxic metals, such as cadmium or aluminium, which the acid may mobilize. Soil acidification has only recently been investigated but may be the most difficult impact to reverse.

27. SO₂ emissions may be reduced substantially through available technologies for modifying fossil-fuel combustion systems. The economic costs, however, are high, and adequate control measures may substantially reduce the economic attractiveness of coal-based power generation. It has been estimated that reducing national annual emissions of sulphur dioxide by 10 million tons/year in the United States (approximately 50 per cent) would cost \$US 3 to 4 billion per year and increase electricity costs by an average of 2 to 3 per cent.

28. Progress on NO_x control technology is less well advanced, but is becoming available for power plants. The indications are that NO_x emissions from mobile sources can be reduced. Again, economic costs are significant - NO_x control was estimated to increase the capital cost of a vehicle by an average of \$US 200 in 1983.

B. Land degradation

29. The problem of land degradation, including deforestation and desertification mainly in developing countries, is more a case of social and economic development than of consumption of an energy source directly causing a specific environmental problem.

30. No discussion of energy-environment issues would, however, be complete without it. Fuelwood is the primary energy source for almost half the world's population, and a substantial proportion of those users are experiencing increasing difficulties in obtaining the fuelwood they need to fulfill basic cooking and

space-heating needs. In certain situations the consumption of fuelwood may be exacerbating the depletion of available resources, but the problem is not a simple question of demand outstripping supply and leading to shortages, as it was perceived in the early 1980s.

31. The proportion of fuelwood consumption derived from trees cut down specifically for fuel is difficult to quantify and may have been greatly overestimated. Trees are cut down for many reasons, primarily to clear land for agricultural production. Some sectors of the fuelwood economy do cause environmental damage, since they rely on trees cut down specifically for fuel. The often cited examples are urban charcoal consumption and industrial/institutional fuelwood use. Persuading consumers to reduce consumption by fuel substitution or improved efficiency may ease the rate of deforestation.

32. The supply problems of the vast majority of consumers - the rural poor - can, however, only be addressed through a more holistic approach to the promotion of better and ultimately sustainable land management. Rural inhabitants generally have no alternative in their daily lives but to continue to exploit standing reserves of trees. They can neither afford nor do they have access to commercial energy sources. Increased emphasis should be placed on strategies to give these issues full consideration in the planning of national energy supply and demand in developing countries.

C. Climate change

33. Scientific evidence shows that rising levels of a range of trace gases are altering the thermal properties of the earth's atmosphere (referred to as global warming) and threatening to cause significant changes in the world climate.

1. The scale of change

34. Some idea of the magnitude of the changes being caused by human activity may be given by the following figures. Ice core sampling of ancient glaciers indicates that carbon dioxide levels in the atmosphere have not changed by more than a few per cent for thousands of years. The combined effect of anthropogenic greenhouse gases will be equivalent to a doubling of CO₂ levels between pre-industrial times and about 2030, if current trends continue. Likewise, the world's average surface temperature has varied by no more than 1°C to 2°C since the last ice age, 10,000 years ago. It is estimated that such a CO₂ doubling would result in an eventual warming of between 1.5°C and 3°C, probably by the second half of the twenty-first century.

35. It must be emphasized that these figures, increasingly familiar, are no more than estimates derived from computer simulations. While past emissions may have already committed the world to a significant level of warming, actual changes to date in key observable parameters directly related to climate (global mean surface temperature, mean sea level) have been within the bounds of natural fluctuations. 6/

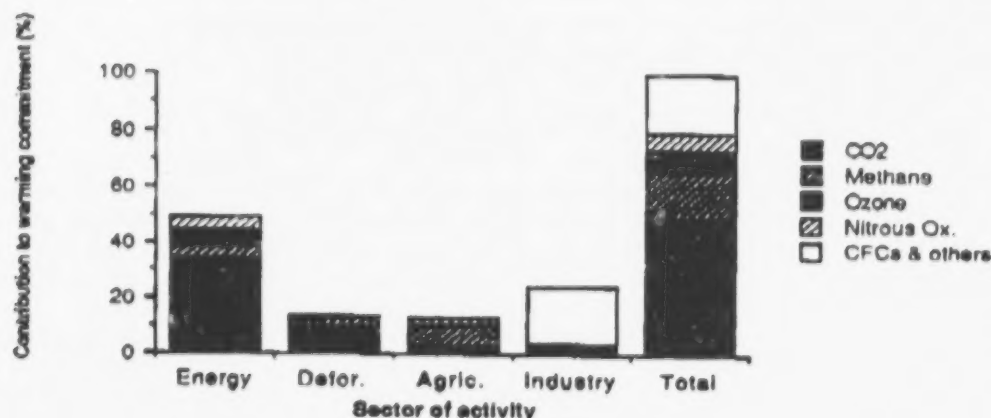
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2. The greenhouse gases

36. The main contributor to the anthropogenic greenhouse effect is carbon dioxide. The key causes of rising CO₂ levels are deforestation and fossil fuel combustion, with fossil fuels now the dominant contributor. More than 5.5 billion tons of carbon in the form of CO₂ are released annually to the atmosphere. 7/

37. The contribution of other trace gases to the greenhouse effect has increased rapidly since the 1960s. Their combined effect is expected to equal that of CO₂ by 2030 if current trends continue. Figure 3 shows the relative significance of the various sectors and trace gases responsible for global warming between 1980 and 2030, assuming current trends continue.

Figure 3. Contribution to global warming, 1980-2030
(projected)



Source: United Nations Environment Programme and the Beijer Institute, The Full Range of Responses to Anticipated Climate Change (Nairobi, UNEPO, 1988).

38. Thus current models suggest that the energy sector will be responsible for approximately half of the greenhouse effect over the coming 40 years. Much of the increase in methane levels is thought to be due to expanding agricultural activity and animal husbandry. Current initiatives to control the greenhouse effect will therefore have to focus on carbon dioxide.

39. In the immediate future, the priority is clearly to reduce the rate of CO₂ emissions. While the significance of deforestation, more specifically the burning of tropical forests, should not be underestimated, these are currently predominantly due to the energy sector.

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3. The consequences

40. Complex feedback effects make it difficult to predict the consequences of global warming. Two consequences that may be expected are sea level rise and changes in the overall level of precipitation. A global warming of 1.5°C to 3°C could cause a rise in mean sea level, probably between 24 and 38 cm by 2050, primarily due to the thermal expansion of the oceans, 6/ with a further eventual rise of up to one meter. 8/ A rise at the upper end of this range could cause major flooding of coastal areas.

41. Rainfall changes are less certain, but most models agree that overall precipitation will decrease in middle latitudes and increase in high rainfall areas in the tropics, with a marked increase in the frequency and intensity of tropical storms. Arid, low-latitude areas such as the Sahel region, might experience more frequent and prolonged droughts.

42. Global warming is an inherent consequence of deforestation and continued heavy dependence on fossil fuels; if the societies of the world are to survive and adapt to its consequences, it is imperative that the pace and magnitude of climate change should be contained.

D. Accumulation of radioactive material

43. The threat of climate change has renewed interest in nuclear power as a possible alternative to coal. This, in turn, has fueled debate on the possible environmental risks associated with the handling and disposal of the radioactive material generated by the production of nuclear fuel and the operation and decommissioning of nuclear reactors. At current levels of nuclear power activity, routine emissions of radioactive material, if all containment procedures are properly observed and no accidents occur, will almost certainly not have a significant impact on the global environment. The importance of scale, however, should be noted. For nuclear power to replace coal entirely in a medium-level scenario by 2025 would require an order-of-magnitude increase in installed nuclear capacity. 9/ Even without such an increase, about 200,000 tons of spent fuel will have accumulated world-wide by the year 2000, and while several studies have concluded that safe disposal of such high-level wastes is technically feasible, no permanent disposal facilities are likely to be in operation before the turn of the century. 10/ It is less easy to quantify the other two main environmental impacts of nuclear power: the risk of accidents and the potential proliferation of nuclear weapons.

44. In many countries, recent events have undermined public confidence in nuclear power as the main energy source of the future. Moreover, the next generation of reactors may prove a substantial improvement, both in safety and in cost-effectiveness, but given these are still untested, a major increase in nuclear power in response to environmental problems caused by fossil fuels seems very unlikely in the near future.

III. THE ROLE OF NEW AND RENEWABLE SOURCES OF ENERGY

A. The options

45. The degradation of the environment caused by current trends in energy consumption calls for immediate action. Some impacts, such as acid rain, land degradation and deforestation, can be alleviated or eliminated through system modifications, without necessarily abandoning the energy sources which contribute towards them. Such measures, however, will not be sufficient to combat the most serious impact of all-global warming. Carbon dioxide extraction from stack gases appears unfeasible at present, since it would more than double power production costs and create unquantifiable waste disposal problems. Steps are therefore required to reduce the impact of CO2 emissions of fossil fuels, particularly coal.

46. Much can be achieved through energy conservation, improving the efficiency of processing of fuels and production of energy and the wider adoption of energy-saving, end-use technologies, such as the use of more efficient cars, electrical equipment and building insulation. Energy conservation, however, will need to be complemented by a change to a better energy mix. Probably the cheapest and the fastest would be an increase in the use of natural gas as a substitute for coal-fired power generation. Given current estimates of natural gas reserves, this can do no more than give a temporary respite; in addition, the danger of increased accidental release of methane, a much more powerful greenhouse gas than carbon dioxide, should not be overlooked.

47. The environmental hazards, mounting public opposition and escalating costs associated with nuclear energy render any major scale-up of nuclear generating capacity unlikely in the medium term. As the "residual sources category", new and renewable sources of energy could therefore play an increasing role in the transition to an energy mix with fewer negative environmental impacts. The following discussion begins, therefore, with an overview of what general characteristics may be identified among the different new and renewable sources of energy, to provide a basis for conjecture concerning their future development.

B. Key characteristics of new and renewable sources of energy

48. A fundamental feature of most new and renewable sources of energy is that they are based on the exploitation of existing energy flows and naturally occurring energy gradients, as opposed to the release of concentrated forms of stored energy, as in the "burning" of fossil and nuclear fuels. This has two general consequences: new and renewable sources of energy applications are, in general, highly site-specific, and their energy supply is intermittent. Thus traditional uses of new and renewable sources of energy have been relatively small-scale and decentralized. There are exceptions, when naturally occurring energy flows are relatively concentrated: a single hydro dam may supply a substantial proportion of a country's electricity (for example, in Zambia).

49. This has its advantages: small-scale energy generation is particularly well-suited to the decentralized rural economies of many developing countries. For

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example, the substantial reduction in the cost of photovoltaic systems in the past 10 years (\$US 15 per peak watt output in 1978, down to \$US 4 in 1988) has opened up an enormous number of decentralized applications, since under certain conditions, photovoltaic power is now competitive with small-scale diesel generation. 11/ In addition, the development of new and renewable sources of energy often provides opportunities for enhancing rural development, since electricity generated by photovoltaic cells, wind and micro-hydro-power can provide the first access to small-scale, non-traditional energy forms in remote areas.

50. However, in order to contribute on a larger scale to the centralized energy systems found in most developed and newly industrialized countries, decentralized renewable sources of energy must be utilized in connection with existing distribution systems. Problems of intermittent supply from some new and renewable sources of energy may be overcome if a baseload supply is available (of the existing new and renewable sources of energy, only large-scale hydro, geothermal and biomass have the potential to provide such a baseload supply). Used in this way, new and renewable sources of energy can provide a relatively environmentally benign and, as is argued below, a potentially cost-effective supplement or alternative to centralized, fossil or nuclear power generation.

51. In the longer term, the problems resulting from the dispersed nature of new and renewable sources of energy may become less critical through the development of improved energy carriers to transport the energy produced to high-demand areas. The possibility of utilizing solar energy to generate hydrogen, which can then be used as a clean fuel, is receiving increasing attention.

52. The development of improved and less expensive energy storage systems, such as batteries, flywheels and water reservoirs is also crucial to overcoming the problem of intermittency for many new and renewable sources of energy applications. The environmental impacts of these energy carriers and storage systems may also be significant in determining the external costs of the energy system as a whole.

C. The environmental perspective

53. From an environmental point of view, new and renewable sources of energy are an essential component of the future energy mix, which is expected to attain the ultimate goal of a sustainable energy future, primarily since almost all of their negative impacts, as described below, may be alleviated or eliminated through appropriate actions or modifications. Their full "cost" is thus internalized and passed on to the energy consumer. It is difficult to envisage a way in which the costs of inherent, unavoidable impacts of conventional energy systems may be internalized so that, for example, the present generation could "compensate" future generations for the effects of climate change. Patterns of energy utilization, which depend on passing costs on to the future are inherently undesirable, since the energy consumer is not thereby obliged to pay the full cost of the energy consumed, discourages conservation even when, with all costs taken into account, the case for using less energy is overwhelming.

54. New and renewable sources of energy technologies may have a major impact on land occupation. With current solar conversion efficiencies, it has been estimated that 100 per cent of the land area of certain countries with energy-intensive economies would have to be covered by collectors if it were to supply all the energy they currently consume. Space requirements are much less daunting if all relevant energy conservation and efficiency measures are taken into consideration before a supply system involving new and renewable sources of energy is established. New and renewable sources of energy cannot be treated as straightforward substitutes for fossil fuels but rather as components of a new system of energy production and use.

55. The impact of large-scale utilization of new and renewable sources of energy clearly cannot be predicted at present, but examples might include: possible seismic occurrences induced by large-scale geothermal power generation, the potential destruction from dam failures associated with hydropower generation, or aquatic changes associated with the large-scale use of OTEC.

56. Although it is not possible to prove, on comparable scales, that new and renewable sources of energy are environmentally preferable to fossil and nuclear fuels, all experience to date supports that assumption. Moreover, tapping existing energy flows and gradients would appear, *prima facie*, to be less likely to result in irreversible environmental degradation than releasing stored, concentrated energy.

D. Specific impacts of new and renewable sources of energy

57. The environmental impacts described above relate to features common to most new and renewable sources of energy. Because of their diversity, however, many of the most important impacts of new and renewable sources of energy utilization are specific to each source. In the final analysis, the negative impacts of new and renewable sources of energy must be compared with the energy-environment problems outlined in section II above.

1. Biomass

58. Since the impacts of biomass use are highly site specific, the present discussion can do no more than indicate where some of the problems may lie. Currently, the main biomass energy source is woodfuel (firewood and charcoal). The difficulty of quantifying its direct impact on resources has been noted in section II. Deforestation in developing countries is undoubtedly the most serious problem associated with biomass energy at present.

59. The commercial extraction of woodfuel, particularly for the urban charcoal market, may contribute directly to deforestation and consequent land degradation in certain areas. On the other hand, it may also provide an important source of income and employment for the rural population. Interventions should therefore aim to promote better production and utilization (through replanting, the use of improved charcoal kilns and improved charcoal cookstoves, such as the successful Kenya Ceramic Jiko), rather than aiming to eliminate woodfuel use altogether.

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60. A second important impact of the use of woody biomass in developing countries is indoor air pollution caused by wood-smoke and charcoal fumes which can contain significant levels of carcinogens. Respiratory diseases were assessed in 1984 to be the most important source of early death among women and children in developing countries. 12/

61. Non-woody biomass sources include livestock manure, urban and agricultural wastes and fuel crops. These are either burnt directly, or processed to produce liquid fuels or biogas. Biogasification is, in many respects, an ideal treatment process for sewage and animal dung. It provides an enhanced fertilizer for agriculture and a relatively clean energy source.

62. It is estimated that India and China have installed 0.2 million and over 7 million biogas plants respectively, 13/ although the proportion of these still in use would be difficult to quantify: failure rates have been estimated to be up to 50 per cent. 14/ Biogasification of urban sewage also alleviates the problem of disposal.

63. The adverse aspects of biogas are the capital cost of biogas plants, the fact that handling sewage is unacceptable in many societies, the difficulties of dung collection and heavy monitoring and maintenance requirements. The direct burning of agricultural wastes as fuel may exacerbate land degradation. Thus their direct use as fuel is generally undesirable.

64. The extraction of energy from the incineration of urban wastes is an important source of district heating in developed countries, with reduced waste bulk as an additional benefit (burning may reduce the volume of urban waste by 90 to 95 per cent).

65. Small-scale "energy cropping", for example, through agroforestry, may yield considerable secondary benefits (such as soil stabilization and improved water retention), as well as provide an energy source in rural areas. Again, this is more an issue of better land management than a simple question of energy supply. Large-scale industrialized energy cropping (either short-rotation forestry or non-woody crops, such as sugar) may be associated with all the side effects of other types of monoculture, which include reduction of the gene pool, reduced resistance to disease in monocrops, soil degradation and the side effects of fertilizers and herbicides.

66. Emissions from the combustion of woodfuel on an industrial scale contain many of the same pollutants as fossil fuels, but the SO₂ content would be significantly lower than for oil and coal.

67. Most of these adverse impacts of biomass use may be avoided through better management practices and the use of improved technologies. Assuming sufficient replanting is undertaken, all the CO₂ emitted from biomass combustion would be re-absorbed through photosynthesis, making biomass a carbon-neutral energy source, although the impact of large-scale biomass production on the organic (carbon) content of the soil is difficult to assess and may be significant.

2. Hydraulic energy

68. Electricity generation from hydraulic energy (hydro) which, being the most established new and renewable sources of energy technology, is expected to increase significantly in the coming years, particularly as developing countries and the centrally planned economies begin to exploit their considerable potential. Large-scale hydro projects have, however, encountered a number of problems, and their environmental impact remains a subject for considerable debate. The capital cost of hydropower development is generally very high, and projects usually involve sophisticated technology. Thus, in a developing country, much of the investment may pass directly overseas, leaving a crippling debt burden. Investments in efficiency or smaller-scale new and renewable sources of energy technologies may not only be more cost-effective but also involve a much smaller foreign currency commitment.

69. Large hydro schemes may disturb water flow patterns, causing sediment to deposit in the reservoir, reducing the dam's effectiveness while at the same time depriving downstream soils of essential nutrients. Reservoirs may occupy large areas of what otherwise would have been productive land and lead to increased incidents of parasitic and water-borne diseases, such as malaria. At the same time the dam would increase overall water loss due to evaporation, and halt seasonal flooding, with serious implications for downstream ecosystems and agricultural areas.

70. The social costs of large-scale hydro projects result mainly from the forced relocation of the inhabitants of areas flooded by dams: for example, the Lau Pao hydro scheme in Thailand involved the displacement of 130,000 people. In sparsely populated areas, however, reservoirs can be socially beneficial, providing opportunities for fishing and irrigation. The risk of dam failure due to seismic activity has been compared to that of a serious nuclear power plant accident in terms of its low probability and potentially catastrophic consequences. In mountainous regions, recent technical advances in underground hydropower development have allowed lakes to be pierced from below, creating a natural reservoir and removing the need for a dam altogether.

71. The social impacts of mini- and micro-hydro development are generally perceived to be much less serious, but less data is available than for large-scale projects. Micro-hydro development has achieved considerable success in developing countries. China, for example, has installed more than 90,000 small hydro plants, with a total installed capacity of 3.7 GW 3/ not including mechanical applications.

72. The environmental problems of micro hydropower are generally site specific and need to be resolved on a local level. Like biomass energy, hydropower development needs to be seen as a multi-sectoral activity involving all aspects of water resource management for its full potential to be realized.

3. Wind energy

73. The two key environmental impacts associated with wind energy are noise and land occupation. The space requirements of wind power production are an inherent consequence of the dispersed nature of wind energy and cannot be avoided. In wind farms, there is a minimum distance (depending on the site characteristics) between wind turbines, below which they are subject to aerodynamic interference. While the space requirement may be a problem for centralized power production, the land between wind turbines can be used for agriculture, particularly grazing of livestock.

74. Small battery-charging wind turbines can provide electricity to remote areas, such as in Inner Mongolia, where more than 50,000 small (50-100 W) units are in operation providing electricity to nomadic herdsman. The development of electricity-producing wind turbines has been very rapid over the last five years, and wind generation costs (particularly in small- and medium-sized units: up to 500kW) have been reduced by more than a factor of 3 since 1980. 15/

4. Solar energy

75. Solar water heating and passive use of solar energy are classic examples of decentralized utilization of new and renewable sources of energy tailored to specific end uses. Solar water heating with flat plate collectors has been very successful throughout the world. Impacts are site specific and generally positive. Capital costs may still be an obstacle, but costs have fallen substantially in recent years. The only negative environmental aspect, besides the visual impact, is associated with potential leaks and disposal of mildly toxic chemicals added to the thermal fluid to prevent corrosion.

76. Passive solar technology includes such fields as solar architecture (window surfaces and orientation, insulation, air recycling). Solar thermal power generation is the only current, relatively large-scale, centralized application of solar energy. Space requirement is the key consideration, but may be acceptable under some conditions, particularly in some developing countries with large areas of otherwise useless desert.

77. A major negative impact of photovoltaic (PV) power generation results from the use of hazardous chemicals in the production of PV cells, and in the batteries needed for energy storage if continuous supply is required. Many of these chemicals are already in use in industry, but large-scale PV power generation will require substantially higher quantities to be handled and consequently higher risks of accidental discharge. Safe disposal of waste material may also pose a problem because of the concentration of heavy metals in the cells.

78. Social benefits of most PV applications at present relate, as do wind and micro-hydro, to the supply of high-grade electrical energy to inaccessible areas, as well as to the enhancement of the effectiveness of communications networks. Centralized photovoltaic power production is at present excluded for reasons of cost, but may become competitive under favourable conditions within the next few

decades if present cost trends continue. 15/ This may lead to very marked increase in photovoltaic power generation, particularly in developing countries.

5. Geothermal energy

79. The only geothermal resource currently under commercial exploitation is hydrothermal power, based on tapping underground reservoirs of hot, pressurized water or steam. Its key attraction for most countries is that it provides an indigenous source of baseload power to substitute for fossil fuel imports. Direct use of hydrothermal resources, for district heating or process heat, is also important and is estimated to provide an energy savings equivalent to over 5 million tons of oil equivalent per year in 1988. 3/

80. The impacts of hydrothermal energy are highly site specific, but the main concern at its current scale of use is the release of toxic trace gases, including hydrogen sulphide, benzene, radon and various heavy-metal compounds, from subterranean sources. The depletion of hydrothermal reserves may also lead to subsidence, as has occurred in Wairakei, New Zealand.

6. Tidal and wave energy, and ocean thermal energy conversion

81. Applications of these energy sources are still restricted to a few pilot plants, thus data on impacts is very limited. Initial indications are that tidal power may have a negative impact on the ecosystems of the estuaries in which it is used by altering flow patterns and increasing siltation.

IV. THE NEW ENERGY AGENDA

82. Although the nominal cost of energy is, at present, relatively low, the environmental "costs" of energy development are becoming prohibitively high. Controlling the total cost of energy to society will therefore necessitate not simply using less but taking an entirely new approach to energy policy and planning.

A. The integration of environmental considerations into energy policy and planning

83. The first step towards controlling the environmental costs of energy production and use is to acknowledge their existence in the energy planning process. At the national level, energy planning traditionally has focused on delivering supplies to meet projected aggregate demand at minimum "cost", narrowly defined as the cost of production and distribution.

84. The recent shift in many developed countries from oil to coal is a clear example of the consequences of the traditional approach. During the period of high oil prices, coal appeared to be the "cheaper" fuel, particularly when used in power stations without sulphur extraction equipment. Yet when the costs of SO₂ removal,

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or the potential cost of acidification of the environment due to failure to remove SO₂, are taken into account, the "true cost" of coal-based power increases significantly. 16/

85. At the micro-economic level, prices charged to energy consumers do not, in general, reflect the true cost of the energy consumed. In the case of electricity in particular, prices often do not even reflect the full internal marginal cost of supply, quite apart from the external environmental costs.

86. "Environmental" costs may broadly be defined in two ways: either as the cost of eliminating or avoiding an impact through appropriate energy system modifications, or as the cost of compensating for or repairing the damage caused by it. Some types of environmental damage may be directly quantified, possibly even in monetary terms, but a number of equally important impacts may only, realistically, be described qualitatively. For the latter, a decision must be made at the political level as to what level of impact may be tolerated, and policies determined accordingly.

87. There is no single, universally applicable methodology for incorporating these considerations into energy policy development: individual countries must develop strategies compatible with their traditions, sectoral structure and available resources. Close international co-ordination, however, will be essential, since issues of international trade are involved. Individual countries will not wish to undermine the competitiveness of their domestic industry. In increasingly international markets, industry will also tend to gravitate towards the laxest regulatory environment.

B. The cost-effectiveness of new and renewable sources of energy

88. Until recently, the capital cost of new and renewable sources of energy technologies has made it unrealistic to consider replacing fossil fuel-based power generation with new and renewable sources of energy on any significant scale. If the full environmental costs are included in the analysis of energy options, however, the case for alternative sources to fossil fuels looks much brighter. Conventional electricity generation from coal and oil typically costs approximately 4 and 6 US cents per kilowatt-hour (kWh) respectively, excluding the cost of flue gas scrubbing and any environmental costs, which, it has been estimated, would add at least 20 per cent to the total. 15/

89. The current cost of nuclear power is much more difficult to determine, since many nuclear programmes do not publish full cost details. Recent studies indicate a capital cost of between \$US 1,000 and 3,000 per kilowatt installed capacity, giving an overall cost (including fuel, operation, maintenance and waste disposal costs and capital depreciation allowing for a typical capacity utilization rate of 0.65) of between 5 and 13 US cents per kilowatt-hour. 9/ 15/ These figures are based on cost calculations as they are presently done, excluding social and environmental costs.

90. By comparison, the capital cost of wind turbines is now approximately \$US \$1,000 per kilowatt installed capacity for 500 kW units. 17/ If operation and

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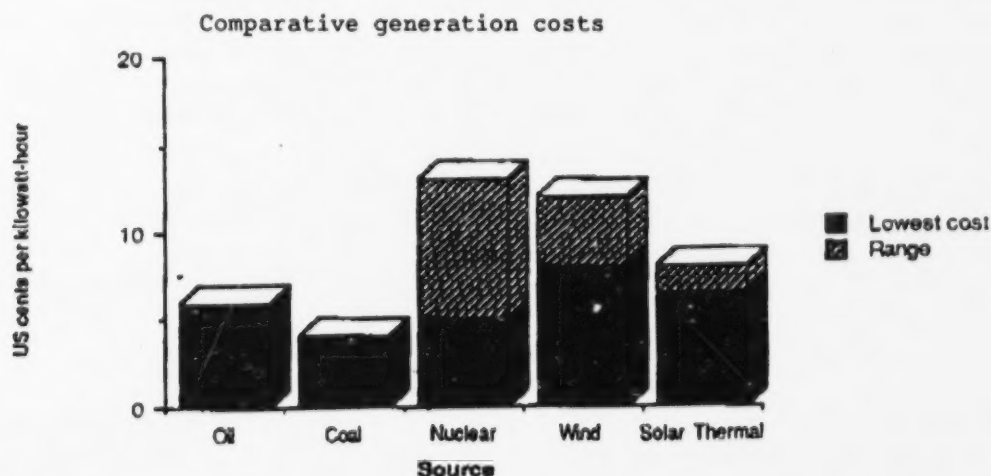
maintenance costs and a typical capacity utilization rate are included, a cost of 8 to 12 US cents per kilowatt-hour output results, depending on site characteristics. These figures, including capacity utilization, have been confirmed by recent Danish experience in practical wind turbine operation which, under favourable conditions, is now producing at 6 to 8 US cents per kWh. ^{18/}

91. The potential costs of solar thermal power may be indicated by recent experience in the Mojave desert in California: capital costs of approximately \$US 2,500 per kilowatt (including all plant costs plus associated structures) giving a lifecycle generation cost of about 8 US cents per kilowatt-hour, allowing for a capacity utilization rate based on several years in operation. ^{19/} This is admittedly an ideal situation, but such desert conditions may be found in many developing countries.

92. It is impossible to give a "typical" cost for hydro or geothermal energy for electricity generation, since costs are so heavily site dependent. Other new and renewable sources of energy technologies have yet to be applied on a scale on which cost figures of this type would be meaningful.

93. Figure 4 shows that, on the basis of a traditional economic analysis, the costs of maturing new and renewable sources of energy technologies are comparable to those of nuclear power, even without taking social and environmental costs into account. It must be emphasized that these cost figures are based on very different scales of application. The above figures have been included simply to indicate that the question of relative cost-effectiveness is, at least, now open.

Figure 4. Economic comparison of fossil fuels, nuclear power and maturing new and renewable sources of energy



Sources: "1989 survey of energy resources", in Proceedings of the Fourteenth World Energy Congress (Montreal, World Energy Congress, 1989) and United Nations Economic Commission for Europe, draft working paper prepared for Expert Meeting on Energy and the Environment, held in Geneva, 1989.

94. Unless the costs of new and renewable sources of energy decrease substantially with larger-scale use, it still remains questionable whether we can afford them at all. Replacing coal with nuclear power by 2020 in the high scenario described in section I would require, in addition to increases which are already projected, over 3 billion extra kilowatts of installed nuclear capacity costing 3 to 11 trillion US dollars. 9/ Since the capital costs of maturing new and renewable sources of energy technologies are comparable to those of nuclear energy (the most which is claimed at present), it may be assumed that a wind-for-coal or solar-for-coal substitution programme, if possible at all, would carry a similar price tag. Clearly, this is not a realistic scenario. The investment in efficiency per kilowatt saved in the course of achieving the "low" energy scenario described in section I is estimated to be about one sixth of the cost of additional nuclear capacity required to displace the same amount of coal-fired generation. Given that the costs are comparable, efficiency would have the same advantage in cost-effectiveness over new and renewable sources of energy.

95. Thus, simply introducing new and renewable sources of energy "plugged in" to the supply side of the existing world energy economy would be both illogical and prohibitively expensive. What is needed is not new energy sources in the existing energy system but a new approach to energy planning and development. It must be recognized that energy production is not an end in itself, nor is a high level of energy consumption automatically associated with economic prosperity. Energy, in so far as it can be considered as a commodity, has a wide variety of uses. The focus of energy policy must take into account the full environmental costs of energy production and use, and not simply be on supplying energy to meet a certain level of aggregate projected demand.

96. In the context of this new approach, new and renewable sources of energy will have a major role to play, particularly when tailored to a large number of specific end-use applications, and they will have a significant advantage in terms of environmental impact. The framework for this new approach is detailed below.

C. Measures to promote environmentally sound energy development

97. The transition to a better energy mix in the future cannot be left entirely to market forces or even to national-level institutions. The present situation has arisen precisely because existing mechanisms in both public and private sectors are incapable of dealing with it. Existing institutions may even oppose the reforms needed to control the environmental impacts of current energy development. The imposition of electricity tariffs to reflect the cost of sulphur extraction and to encourage a reduction in carbon emissions may lead to protests from national industries that their competitiveness is being undermined. Major investment in renewable energy development for the sake of the next generation may be extremely difficult to promote, particularly in poorer countries with large numbers of people in need of immediate assistance to satisfy their basic human needs.

98. Yet the development towards a sustainable energy future should not be seen as a brake on economic development. There may be clear, immediate economic benefits to be derived from energy conservation and an increased use of new and renewable

sources of energy, particularly in the decentralized economies of developing countries. Nevertheless, a commitment is required from all countries, since action on energy-environment issues will only be effective if it is co-ordinated at the global level.

99. Action may be taken on a number of fronts:

Legislation

- (a) At the international level, a commitment to combat climate change;
- (b) Existing regional and international protocols on the control of transboundary transport of pollution to be ratified;
- (c) Regulations regarding the disposal of radioactive waste should be strictly adhered to, and the practice of transporting waste to less developed regions without proper disposal facilities completely prohibited. Regionally co-ordinated action is required on the problem of deforestation;
- (d) International initiatives must be supported by appropriate national legislation.

Economic incentives and public awareness

- (a) Energy prices in most countries are heavily influenced by national policy. In many cases, these do not even reflect the cost of production and distribution, let alone the social and environmental costs associated with energy. Many current energy pricing policies, particularly electricity and petroleum subsidies, distort the economy in favour of some of the worst energy sources from the environmental point of view, which discourages investment in new and renewable sources of energy;
- (b) Reducing overall energy consumption may be economically beneficial for many countries, since the cost of efficiency improvements may be substantially less than the cost of increased energy production capacity: a recent study commissioned by the Canadian Government found that Canada could reduce overall CO2 emissions by 20 per cent by 2005, mainly through investment in efficiency and new energy sources, and save over 100 million Canadian dollars in the process. Developing countries may benefit substantially from increased emphasis on conservation in their energy policies;
- (c) Reappraisal of energy pricing policies must therefore be a priority;
- (d) An essential component in the transition to realistic energy pricing will clearly be the promotion of public awareness of the true cost of energy, including costs to the environment.

Improving investment attractiveness for new and renewable sources of energy

In a conventional economic analysis, the cost-effectiveness of new and renewable sources of energy is very sensitive to the terms under which investments are evaluated, specifically the discount rate and investment horizon.

Research, development and demonstration

While realistic prices for conventional energy sources will automatically improve the economic case for new and renewable sources of energy, there is a clear role for international and national support to research, development and demonstration projects. New and renewable sources of energy-based energy projects, due to their site-specific nature and relative novelty, often have particularly high technical development costs. Research and development in end-use efficiency and renewable energy sources has suffered from underfunding for many years. ^{15/}

International co-operation and technology transfer

(a) There is a clear need for co-operation on both the technical and the economic fronts. Suggestions are that industrialized countries should assist less developed countries in managing the transition to a better energy future;

(b) Bilateral and multilateral assistance should aim at promoting both expanding energy supplies and satisfying the needs of end-users through conservation;

(c) The proportion of energy-related overseas aid should be increased.

D. The need for a site-specific response

100. Because they are site-specific, measures to promote new and renewable sources of energy must clearly be tailored to the particular geographical, economic and social conditions of the area of application. The most important question is how national, regional and community planning of energy supplies should be integrated with rural development planning. As with conservation measures, it is the cumulative effect of large numbers of local-level initiatives that will have an impact on the international energy situation.

V. PRIORITY ACTION AREAS

101. At the end of the 1980s, the world energy agenda is dominated by the environment, just as at the beginning of the decade, it was dominated by oil prices and supplies. Action on new and renewable sources of energy called for in the 1981 Nairobi Conference has been way below expectations. The key argument put forward for the development of new and renewable sources of energy at that time, namely to increase their contribution in relation to fossil fuels, lost validity as the short- and medium-term supply situation appeared increasingly secure.

102. In the context of the new energy agenda, there is a new rationale for new and renewable sources of energy: as relatively environmentally benign energy sources. In order to work in this direction, Governments, international organizations and industry should take action in the following key areas, which are compatible with the areas of priority action identified in the Nairobi Programme of Action:

(a) Develop strategies for a global response to climate change. Scientific recognition of the urgency of the problem of climate change must be translated into an international commitment for action. A framework for international co-operation is essential, in particular to assist developing countries, who will play a crucial role in any effort to combat global warming, to overcome the costs of transition.

(b) Introduce end-use oriented environmentally-sensitive energy planning. National energy policy decisions must be based on the full costs and benefits of the different options to the environment and society as a whole. The development of energy planning tools which take into account environmental costs is an urgent priority. The focus of energy policy formulation must move away from simply delivering an adequate aggregate supply towards satisfying specific end-user needs in the most cost-effective way. This will involve a much more interdisciplinary approach. All forms of energy developed should be seen as complementary and should be used to reinforce rural development. New and renewable sources of energy, tailored to specific end-use applications, can play a crucial role in such an integrated approach and should be given due prominence in all discussions relating to sustainable development and environmental protection.

(c) Support environmentally sound energy development. A commitment is required to energy pricing policies that ensure a true reflection of costs, including environmental costs. Only then will the true cost-effectiveness of new and renewable sources of energy become apparent. Since this will involve major changes in many national economies, it can only be achieved as a long-term goal. In the mean time, public awareness of the true cost of energy should be promoted, and the practice of subsidizing fossil fuels and fossil-based electricity, which encourages inefficient use, should be ended. International co-operation on this issue is essential. A commitment to including environmental costs into energy prices will be an essential component in any global convention on climate change. The experience of various countries in the use of incentives to promote energy conservation and the increased use of new and renewable sources of energy could usefully be shared with other United Nations Member States. ▼

(d) Improve the global data base on new and renewable sources of energy. The lack of internationally comparable data makes it difficult to monitor growth prospects and assess the potential for new and renewable sources of energy. More data is particularly needed on the environmental impacts of new and renewable sources of energy, since little is known at present, owing to the small scale of most current applications.

(e) Increase research, development and demonstration activities. Years of underfunding of new and renewable sources of energy activities must be compensated for by a major renewed research, development and demonstration effort. Particular emphasis must be placed not on the development of new technologies but on tailoring

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existing technologies to specific end-uses and particular environmental and social conditions.

(f) Create or provide favourable financing arrangements for new and renewable sources of energy applications. The capital cost of many new and renewable sources of energy applications is a major hurdle to their increased use. Assistance at both the national and international levels in overcoming this cost will be more than justified by the long-term benefits to society.

(g) Strengthen international co-operation and technology transfer. The high research, development and demonstration costs required for the more widespread development and application of new and renewable sources of energy make it imperative that the transfer of technologies, particularly from developed to developing countries, be facilitated. International industrial co-operation on new and renewable sources of energy development should be encouraged.

Notes

1/ See Report of the United Nations Conference on New and Renewable Sources of Energy, Nairobi, 10-21 August 1981 (United Nations publication, Sales No. E.81.I.24), chap. I, sect. A.

2/ See "Energy perspectives, 2000-2020", in Proceedings of the Fourteenth World Energy Congress (Montreal, World Energy Congress, 1989).

3/ See "1989 survey of energy resources", in Proceedings of the Fourteenth World Energy Congress (Montreal, World Energy Congress, 1989).

4/ See statement by Hall and Rossillo-Calle to World Energy Congress, 1989, in Proceedings of the Fourteenth World Energy Congress (Montreal, World Energy Congress, 1989).

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